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Outbreak of Swimmer's Itch in Denmark

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Swimmer's itch, or cercarial dermatitis, is a waterborne non-communicable skin condition caused by schistosome cercariae released by aquatic snails. Cercarial dermatitis appears worldwide, but may be caused by different trematode species. The itchy maculopapular rash develops on exposed areas of the skin and typically resolves within 1–3 weeks. Shedding of infective larvae from snails is temperature dependent, and high temperatures and sunshine increase the risk of encountering the parasite and becoming infected. The unusually warm spring and summer of 2018 led to an increasing number of reports of the condition in Denmark and established a collaboration between the Department of Dermatology and the Faculty of Health and Medical Sciences, Department of Veterinary and Animal Sciences. This study explored the clinical picture of the disease, and demonstrated the occurrence of infected fresh water snail species in selected Danish water bodies. In conclusion, a risk of swimmer's itch in Denmark was confirmed.

Key words: swimmer's itch; cercarial dermatitis; *Trichobilharzia*.

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Swimmer's itch, or cercarial dermatitis, is a waterborne non-communicable skin condition. It is caused by various species of skin-penetrating schistosome cercariae (1), which are larval flatworm parasites emerging from aquatic snails that occur worldwide, usually in freshwater. The avian schistosomes most often responsible for the infection have a 2-host lifecycle: snails as intermediate hosts and birds as final hosts. These non-human schistosomes are considered unable to complete their development in human hosts, where they become entrapped in the skin and die soon after penetration, inducing an intense inflammatory response (2).

A few hours after exposure to water carrying infective cercariae, the affected person develops an itchy maculopapular rash, limited to areas immersed in water. The itch becomes more intense and the rash typically develops with papules and vesicles during hours or a few days after exposure. The disease is self-limiting within 1–3 weeks.

SIGNIFICANCE

Swimmer's itch is an emerging disease in Europe, which is usually considered benign. This study explores the clinical picture of the disease, demonstrates the occurrence of the causative parasite in selected Danish water bodies, and confirms the risk of swimmer's itch in Denmark.

If repeated exposures occur, the reaction is often more rapid and severe, indicating sensitization and allergic reactions (2–4).

In temperate climates, swimmer's itch is a seasonal disease mainly diagnosed during summer months, when both the number of open-water activities and snail release of cercariae reach peak levels (5).

The period from spring to the end of summer 2018 was unusually warm (6). Open-water activities flourished and so did the parasites. Increased reports of eruptions resembling swimmer's itch began to emerge locally and in the media, reaching the Danish Nature Agency and local dermatologists. This led to a collaboration between the Department of Dermatology, Odense University Hospital and the Faculty of Health and Medical Sciences, Department of Veterinary and Animal Sciences, University of Copenhagen, with the aim of further exploring the clinical picture of swimmer's itch and investigating the occurrence of *Trichobilharzia* infected snails in selected Danish water bodies.

MATERIALS AND METHODS

A protocol was prepared and submitted to the Data Protection Agency, which approved the data collection [Jr 18/41986]. Invitations were published using the homepage of the Danish Nature Agency, the mailing list of the Danish Society of Dermatologists, and local bulletins for persons experiencing a rash after bathing in freshwater lakes. Affected persons were invited to contact our department by phone or e-mail. Those who contacted the department were asked to send pictures of the rash for dermatological evaluation; they were offered a clinical examination in case of actual eruption, and asked to complete a questionnaire. Information was gathered about age and sex, bathing coordinates, duration of bathing, latency before skin eruption, a description of the rash, location, duration, treatment and accompanying symptoms, such as fever, malaise, physician contact or hospitalization. Data on comorbidities and other therapies were also collected.

In parallel, in order to assess the risk of swimmer's itch and the occurrence of avian schistosomes, we visited the la-

kes and nearby locations from which there were reports of cases of swimmer's itch, sampling freshwater snails in order to examine for the occurrence of *Trichobilharzia* cercariae. The host snail species were collected from August to November 2018 from 9 Danish freshwater lakes. Every site was sampled once. The snails were collected by hand, forceps or wire-mesh scoop from shallow waters and subsequently transported under refrigerated and moist conditions in plastic beakers with perforated screw caps to the Laboratory of Aquatic Pathobiology, for parasitological examination. Each snail was isolated individually in a small plastic beaker containing 100 ml dechlorinated water and placed overnight in natural light at room temperature to induce cercarial shedding. The following morning, shedding was recorded by the use of a Leica MZ 9 dissection microscope (magnification 6–40×) with sub-illumination. If cercariae were observed, they were mounted on microscope slides and examined using a Leica DM5000 B light microscope (Leica Microsystems, Wetzlar, Germany) (magnification 400×).

The cercarial type and genus were determined morphometrically according to Wesenberg-Lund (7), Frandsen & Christensen (8) and Schell (9), and specimens identified as *Trichobilharzia* sp. were isolated and preserved in 70–96% ethanol for subsequent molecular confirmation of genus designation.

RESULTS

The department received information on 29 patient cases who had experienced symptoms resembling swimmer's itch after bathing in 6 different Danish freshwater lakes. Some informers reported on behalf of their children/grandchildren. Three persons were excluded because the rash had occurred in previous bathing seasons. Two cases were excluded as they experienced itch only after swimming and had no rash. Six cases were excluded as they did not provide sufficient details on their eruption. Of the remaining 18 persons, 11 completed the questionnaire and 7 provided details by e-mail text. **Table 1** describes the results of the questionnaire. Photographs provided by the affected persons are shown in **Fig. 1**.

A total of 418 snails were collected, representing 247 *Lymnaea stagnalis*, 142 *Radix balthica* and 29 *Planorbis corneus*. The snails were collected from 9 different freshwater lakes reported by patient cases and also some nearby locations. Ten snails from 5 different sampling

Table 1. Cases of swimmer's itch in freshwater lakes, Denmark 2018

Case no.	Age, years/sex/ lake	Symptom latency, h	Rash	Systemic symptoms	Duration, days	Other episodes of swimmer's itch	Contact to healthcare professionals	Treatment	Comments
1	77/M/Almindsø	14	Itchy rash with multiple papules, vesicles and excoriations on arms, legs and trunk	No	7	No	Yes	No	Persistent itch 4 months later. Bathes every day spring-summer
2	18/F/Almindsø	–	Multiple papules arms, legs and trunk	–	–	–	–	–	–
3	70/F/Buresø	–	Rash	–	–	Several times 2003–2018	–	–	2 more cases without details
4	48/M/Esrum sø	2–3	Multiple elements on legs, initially papular but later with small pin-point haemorrhages	No	14	No	No	–	–
5	65/F/Esrum sø	3–8	~50 papules and pustules	No	3–5	Several times	No	–	–
6	61/F/Esrum sø	2–12	Papular rash on legs and trunk	No	3–4	No	Yes	Topical corticosteroid	–
7	–/M/Esrum sø	~1	Itchy vesicular rash with excoriations and secondary yellow crusts on legs	No	7–10	Yes, several times 2010–2018	No	–	Milder after a changed swimming route avoiding seaweed
8	–/F/Esrum sø	24	Itchy red papules and wheals on arms, legs and trunk	–	7	Yes, several times	–	–	–
9	36/F/Esrum sø	24	50 intensely itchy papules on arms, legs and trunk	No	3–4	No	No	Anti-histamine Aloe vera	–
10	7 /F/Esrum sø	24	A few lesions	No	7–10	No	No	Anti-histamine	–
11	10/M/Esrum sø	24	Universal multiple elements	No	10	No	No	Antibiotic cream	–
12	10/M/Esrum sø	12	70–80 papules on arms, legs and trunk	No	2–3	No	No	Antibiotic cream	–
13	11/F/Esrum sø	12	Multiple papules	No	2–3	No	No	Antibiotic cream	–
14	11/F/Esrum sø	48	Multiple papules	No	–	No	No	–	–
15	63/M/Furesø	0.25	One single papule	No	7	No	No	None	Atypical
16	1/M/Kvie sø	36	25–30 erythematous papules on head, arms and legs	No	14	No	Yes	None	Bathes frequently
17	6/M/Ringen sø	1–2	Itchy papules	No	1	Yes, once before, other location	No	Tea tree oil	–
18	4/F/Vedsø	2	Itchy red papules on arms, legs and trunk. Some left scars	No	7	Yes, several times 2012–2018	No	Hydrogen peroxide	+ 4 cases without details



Fig. 1. Photographs provided by the persons with swimmer's itch.

sites released avian schistosome cercariae. The snails from Vedsø did not survive long enough to be examined for cercarial output. The prevalence of cercariae in the examined snails from 8 freshwater lakes is shown in **Table II**. Avian schistosome cercariae were found in 4 out of 247 (1.6%) *L. stagnalis* and in 6 out of 142 (4.2%) *R. balthica*. None of the *P. corneus* snails were infected. The different isolates of *Trichobilharzia* were not identified beyond the genus level. A photograph of the *Trichobilharzia* cercaria is shown in **Fig. 2**.

DISCUSSION

Swimmer's itch was first described as cercarial dermatitis in 1928 at Douglas Lake, Michigan, USA, by Dr William Cort, when handling snails resulted in the development of a rash (1). Cort found that it was cercariae of avian schistosomes that caused the rash by penetration of the human skin while emerging from their intermediate snail host. In the 1930s the Danish naturalist Wesenberg-Lund described the occurrence in Danish freshwater lakes of

snails infected with avian schistosomes, and postulated the possibility of human cases of swimmer's itch in Denmark (7). The first cases of cercarial dermatitis were registered and characterized in Hjørring, Jutland in the 1950s (10). Although schistosomes in general are noted to cause dermatitis, it is those of the genera *Trichobilharzia* and *Bilharziella* that are most notably the aetiological agents in freshwater ecosystems in Denmark. Previous studies on the occurrence of avian schistosomes in Danish freshwater lakes identified *T. regenti*, *T. franki*, *T. szidati* and *Bilharziella* sp. (11–13).

The current study confirms the risk of swimmer's itch in Denmark by detecting the occurrence of snails releasing avian *Trichobilharzia* cercariae in 5 freshwater lakes with corresponding reported cases in the area. Surprisingly we did not find cercaria shedding snails in Lake Esrum, from where we had many reported cases. However, Lake Esrum has previously been recorded as infected (14), and snail samples taken in the nearby Arresø only 17 km west of Lake Esrum had a prevalence of infection of 4.8%, and snails from Furesø, 23 km south of Lake Esrum, had a prevalence of 5.8–8.3%. *Trichobilharzia* species utilize waterfowl as the final host in which they mature into

Table II. *Trichobilharzia* positive snails in Danish freshwater lakes in 2018

Location/ Lake	Collected snails, n	Snail species (n)	Prevalence, %	Parasite genus
Jutland/DK/ Almind Sø	11	<i>L. stagnalis</i> (10) <i>R. balthica</i> (1)	– –	
Jutland/DK/ Buresø	2	<i>L. stagnalis</i> (2)	–	
Zealand/DK/ Arresø	92	<i>L. stagnalis</i> (33) <i>R. balthica</i> (41) <i>P. corneus</i> (18)	– 4.8 –	<i>Trichobilharzia</i> sp.
Zealand/DK/ Darup sø	30	<i>R. balthica</i> (30)	3.3	<i>Trichobilharzia</i> sp.
Zealand/DK/ Esrumsø	120	<i>L. stagnalis</i> (88) <i>R. balthica</i> (27) <i>P. corneus</i> (5)	– – –	
Zealand/DK/ Farum sø	50	<i>L. stagnalis</i> (18) <i>R. balthica</i> (26) <i>P. corneus</i> (6)	– 7.7 –	<i>Trichobilharzia</i> sp.
Zealand/DK/ Furesø	41	<i>L. stagnalis</i> (24) <i>R. balthica</i> (17)	8.3 5.8	<i>Trichobilharzia</i> sp.
Zealand/DK/ Ringensø	72	<i>L. stagnalis</i> (72)	2.7	<i>Trichobilharzia</i> sp.



Fig. 2. *Trichobilharzia* cercariae released from the freshwater snail *Radix balthica* sampled in Lake Furesø. (A) An intact cercaria (furcocercaria) composed of forebody with eye-spots and everted ventral sucker and equipped with tail. (B) Forebody (the skin penetrating part of the parasite termed schistosomulum) following shedding of tail. Scale bar: 100 µm.

adult worms. After leaving their snail host, the cercariae remain infective for 1–3 days (15) and can be actively dispersed by swimming within a radius of 100 m (16). Moreover, they can be passively carried by water currents several km downstream, posing an infection risk in wider areas, even though the risk is highest in lymnaeid snail habitats. The detection of the parasites is difficult and requires extensive screening of snail populations, as a low prevalence of *Trichobilharzia* spp. of 0.6–3% is typical for avian schistosomes, also in areas where swimmer's itch occurs in humans (17, 18). The probability of finding infected foci may decrease with increasing surface area. As Lake Esrum is the second biggest, with highest volume of water, lake in Denmark, (surface area 17.3 square km), the results suggest that infected snails are not evenly distributed in the lake. Thus, minor infection foci, not recorded in our study, will probably contaminate larger areas by spreading infective cercariae via water currents. We therefore advocate for increased sampling and further investigation of this lake in the future.

The diagnosis of swimmer's itch is made on the basis of clinical findings after relevant exposure. Our data rely on self-reported cases, with risk of recall bias. The disease is self-limiting, and under-reported cases are probable. Our data showed a great variation in symptom onset and duration of symptoms. None of our cases described systemic symptoms with fever or malaise, and only a few cases contacted professional healthcare.

To date there is no clinically available PCR method to detect this disease, and differential diagnoses, such as phytoplankton dermatitis, urticaria, seabather's eruption, insect bites, viral exanthemas or other diagnoses, should always be kept in mind. Human schistosomes can also produce a similar rash after penetration of the skin (3), seen in approximately 36% of patients with schistosomiasis (19). Human schistosomes have not hitherto been described in northern Europe. In our study the *Trichobilharzia* subtype was not specified, but none of our cases showed signs of systemic disease. Earlier experiments in animal models with avian schistosome cercaria *Trichobilharzia szidati* and *T. regenti* showed that they possess potential to penetrate the skin of unsensitized mammals, as well as exhibit species-specific migration patterns within vertebrate bodies, infecting different organs/tissues and causing neurological disorders or haemorrhages (20, 21). It remains unclear whether these symptoms can occur in humans, so up-to-date swimmer's itch is still considered to be a benign skin disease.

Global warming and climate changes are considered important risk factors for parasite prevalence in lakes, as elevated temperatures can provide favourable conditions for overwintering migratory birds, schistosomes and snail hosts (22). High temperatures and sunshine also correspond with a higher infection risk, as cercarial shedding is elevated on sunny days and in warm water (23). The warm temperature moreover leads to a higher use of open-water activities, which increases the risk of encountering the parasites (24). Eutrophication is also an important ecological risk factor for swimmer's itch, and most European cases of this disease are registered in manmade water bodies or eutrophic lakes (25). Beside the environmental risk factors, the risk of disease is also correlated with bathing behaviour and bathing duration. The risk of infection is higher in people engaged in immersed activities, such as wading and swimming, as opposed to surface activities, such as wind surfing and water skiing (26). The snail beds are typically most dense in shallow water and the cercariae tend to accumulate in localities with rich aquatic vegetation, so the risk of infection is highest when bathing here. Young children, who typically spend more time bathing in the warm, shallow water along the shores, have a higher prevalence of infection (5, 26). The risk of disease is also higher when bathing in morning hours, since most of the cercariae are released from their snail hosts in the early mornings (26, 27). The risk of infection likewise increases with higher bathing frequency and duration of time spent in the water (27). The increasing frequency of reports of cercarial dermatitis in Denmark might also reflect a greater awareness of the disease among the general public. There are many possible preventive measures to reduce the occurrence of parasites in the water, but most of them are labour intense, difficult and expensive, with uncertain effectiveness and with a risk of high ecological

costs. Simple measures, such as information boards encouraging people not to feed waterfowls due to infection risk, might be helpful (28).

Preventive actions before or after water exposure, such as the application of cream formulations that inhibit cercarial skin penetration (29), showering and towelling after swimming (30), avoiding shallow water and morning swims (5, 26) have been proposed and may lower the risk of swimmer's itch infection, but there is no guarantee of total safety as long as freshwater lakes are used for bathing activities.

This study confirms the occurrence of swimmer's itch and *Trichobilharzia* cercariae in Denmark. The disease might be emerging in northern Europe due to climate change, is considered to be benign, and none of our cases showed signs of systemic disease. We recommend developing a PCR-based diagnostic method, which could be applied on skin biopsies to specify the diagnosis. The relatively high prevalence of infected snails in the present study calls for further monitoring of these pathogenic cercariae in European freshwater localities. Further studies are needed to assess the prevalence of the disease, and to assess if there is a risk of systemic infection in northern Europe.

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